

Retrospect: A Hybrid Decision Support System in the Domain of Breast Cancer Treatment Planning

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Background. One of the most fundamental issues in the ongoing debate over health care reform centers around the question of how to “protect” quality of care as cost-saving plans are implemented. Maintaining this quality of care in the face of decreasing economic support will likely only be possible if concomitant increases in efficiency are achieved. Given this need for increased efficiency, and the growing body of evidence suggesting that unintentional variability in health care delivery impedes both efficiency and efficacy of care, the motivation behind the drive to leverage modern technology to empower tomorrow’s physicians to make more consistent, informed decisions becomes clear.

The purpose of this ongoing project is to develop a conceptual model for the design of advanced decision support systems, and to apply this model to the construction of a prototype system in the domain of breast cancer treatment planning. The model developed for this purpose is based upon a “three-tiered” view of health care delivery: initial patient situation, treatment, and outcome. The goal of systems based on this model, following exposure to and learning from historical case data, is two-fold. First, given an initial patient situation and treatment, such systems should be able to predict the outcome. Second, given an initial patient situation and a desired outcome (such a maximal time before recurrence), such systems should be able to recommend an optimal treatment. Essentially, this amounts to providing the model with any two of the three “tiers” in the health care delivery model, and asking it to derive the third.

System. Retrospect is a prototype decision support system designed to validate the conceptual model of health care delivery (and resulting processing paradigm) discussed above. Specifically, its goal is to predict treatment outcomes and recommend optimal treatment plans for patients with breast cancer. To meet these goals, Retrospect relies on a combination of interacting artificial intelligence methodologies (often referred to as a “hybrid

architecture”). This architecture is necessitated by the fact that the system’s two “sub-goals” (i.e. prediction vs. recommendation) have very different computational requirements. The prediction engine is based on a neural network, enabling it to learn treatment-outcome patterns and form generalizations based on these patterns. The recommendation component of Retrospect, which requires search through a tremendously large “space” of possible treatments, is based on a genetic algorithm designed to traverse this space efficiently, evaluating treatment options using the outcome predictions of the aforementioned neural network, until an “optimal” treatment option is found (i.e. one whose predicted outcome best matches the desired outcome). Thus, Retrospect’s two components use very different but inter-dependent processing strategies to meet the system’s overall goal.

Retrospect is currently available in two forms: a “local” version which runs in a 32-bit Windows environment, and a “distributed” version which consists of a “thin” Windows client and an Internet server application. Future additions of the distributed version will include a Java-based front-end for greater security and cross-platform support.

Evaluation. An evaluation of Retrospect’s performance is currently underway, and initial results appear promising. Clinical validation of the system’s predictions and recommendations is being performed both through the use of historical cases previously unseen by the system and through comparison to case analyses by experts in the field of breast cancer research and treatment.

Conclusions. The potential rewards for pursuing the development of advanced decision support systems such as Retrospect include increases in both the efficiency and efficacy of health care delivery. As we move into an era in which the imposition of ever stricter limitations on health care spending are likely, such increases may play a vital role in maintaining our ability to deliver the quality of care that our patients expect and deserve.